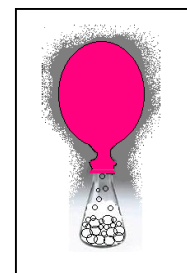


Activity #15

Title: Law of Conservation of Mass-Teacher's Copy

(Lab teams of 2-4 students)



Note to the teacher: Although this activity can be performed as a student laboratory exercise, it is rather difficult for young hands to “package” the baking soda and then insert it into the various containers without losing any of the carbon dioxide produced. If you decide to perform this as a teacher demonstration with class participation, you should practice this procedure beforehand to minimize the embarrassment of spilled chemicals (as harmless as they are...) or from losing the products from the reaction.

It can be stressed to the students that because the Law of Conservation of Mass is, in fact, a law, it has never been proven incorrect to date. We in the public school laboratory are not about to disprove something that has withstood the test of time over the decades/centuries. However, in order to **verify** this law, our experimental procedures must be consistent with accepted laboratory technique and our interpretation of collected data must allow ourselves to state explanations for the relationship between the variables under consideration.

National Science Education Standards addressed:

Science Content Standards: 5-8

Science as Inquiry

CONTENT STANDARD A:

As a result of activities in grades 5-8, all students should develop

- **Abilities necessary to do scientific inquiry**

Understandings about scientific inquiry

GUIDE TO THE CONTENT STANDARD

Fundamental abilities and concepts that underlie this standard include

ABILITIES NECESSARY TO DO SCIENTIFIC INQUIRY

DEVELOP DESCRIPTIONS, EXPLANATIONS, PREDICTIONS, AND MODELS USING EVIDENCE. Students should base their explanation on what they observed, and as they develop cognitive skills, they should be able to differentiate explanation from description--providing causes for effects and establishing relationships based on evidence and logical argument. This standard requires a subject matter knowledge base so the students can effectively conduct investigations, because developing explanations establishes connections between the content of science and the contexts within which students develop new knowledge.

THINK CRITICALLY AND LOGICALLY TO MAKE THE RELATIONSHIPS BETWEEN EVIDENCE AND EXPLANATIONS. Thinking critically about evidence includes deciding what evidence should be used and accounting for anomalous data. Specifically, students should be able to review data from a simple experiment, summarize the data, and form a logical argument about the cause-and-effect relationships in the experiment. Students should begin to state some explanations in terms of the relationship between two or more variables.

Physical Science

CONTENT STANDARD B:

As a result of their activities in grades 5-8, all students should develop an understanding of
Properties and changes of properties in matter

GUIDE TO THE CONTENT STANDARD

Fundamental concepts and principles that underlie this standard include

PROPERTIES AND CHANGES OF PROPERTIES IN MATTER

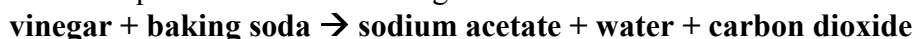
Substances react chemically in characteristic ways with other substances to form new substances (compounds) with different characteristic properties. In chemical reactions, the total mass is conserved. Substances often are placed in categories or groups if they react in similar ways; metals is an example of such a group.

Purpose: To attempt to verify the Law of Conservation of Mass - *In any chemical reaction, the total mass of the reactants is always equal to the mass of the products.* (What goes in must come out!)

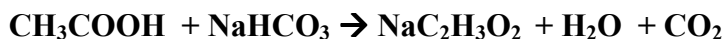
Materials: (per lab team) laboratory balance, weighing dish, 600 mL beaker, 1 large 12” balloon (with wide neck), 1 sheet of facial tissue (or lens cleaning paper), 3 liter soda bottle/cap (or 1.75 liter apple juice bottle/cap or any similar large-mouthed container), laboratory funnel, 250 mL flask, graduated cylinder, ~30 g baking soda, ~100 mL vinegar,

Hazards/Precautions: Because you will be handling a weak acid, safety goggles will be worn.

Introduction: The word equation for the following reaction is as follows:

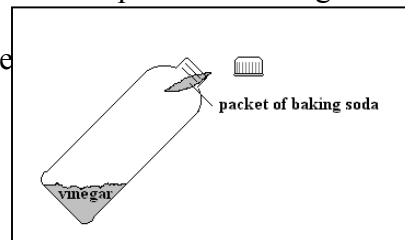


The chemical equation for the reaction is:



Procedure:

1. **(Trial #1)** Pour about 30 mL of vinegar into the beaker. Place about a tablespoon of baking soda into about a 1/3 section of the facial tissue and fold the contents into a neat little “packet.” Place the beaker/vinegar and the packet of baking soda on the pan of the laboratory balance. Measure and record the mass of these reactants/containers on the attached data chart.
2. Carefully place the packet into the beaker and allow the reaction (fizzing and bubbling) to complete. Measure and record the mass of the remaining products. (Expect mass to be lost at this juncture.)
3. **(Trial #2)** Pour about 30 mL of vinegar into the 3-liter bottle using the funnel (to avoid getting the neck of the container wet). (Wetting the neck with the vinegar would possibly cause the reaction to begin before securing the cap.) Prepare another packet of backing soda/tissue as in step # 1 above and measure and record the total mass of these reactants before mixing.
4. Tilt the bottle (as much as possible without spilling the contents), insert the packet of baking soda into its neck (being careful not to wet it) and tightly secure the cap.
5. Tip the bottle upright and allow the contents to fully react. Measure and record the mass of the container/products. (Expect the mass here to

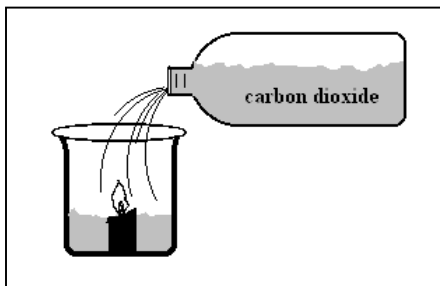


equal that of the reactants.)

6. **(Trial #3)** Pour about 30 mL of vinegar into the 250 mL flask using the funnel to make certain the neck of the flask does not get wet. Prepare the last packet of baking soda as before and now determine and record the mass of the reactants, the flask **and the balloon** (which will be the “cover” for this container).
7. Tilt the flask (as you did the bottle in step #4) and slide the packet just into its neck, being careful not to let it slip into the vinegar. While one student holds the tilted flask tightly, another must slip the open end of the balloon over the mouth of the flask. Tip the flask upright and allow the reaction to fully complete. (Of course, the balloon will inflate with the carbon dioxide produced by the reaction.) Measure and record the mass of the products/container/balloon. (Although the flask was, in fact, covered as in trial #2, the mass here is decidedly less than that of the reactants!)

Inquiry/Analysis:

1. In which trials was the Law of Conservation of Mass DEMONSTRATED?
2. In which trials was the Law of Conservation of Mass VERIFIED (confirmed, proven)?
3. Why was there a difference between the mass of the reactants and the mass of the products in Trial #1?
4. Why do you suppose the mass of the products compared as they did to the mass of the reactants in Trial #2?
5. If the container in Trial #3 was covered (with the balloon), offer an explanation as to where the discrepancy (difference) arose between the mass of the reactants and the mass of the products. (Hint: Think of the helium-filled balloons you once had which were floating near the ceiling in the evening, but resting on the floor in the morning!)
6. From observing your teacher’s post-lab demonstration, describe two properties (one physical and one chemical) of carbon dioxide.



7. How do you know that the carbon dioxide was denser than the surrounding air in the room?
8. How do you think the mass of the bottle (with contents) compares AFTER pouring out the CO₂ as to BEFORE the pour when it was filled with carbon dioxide?

Bonus: Balance the chemical equation (see the Introduction) for the reactions that took place in this activity. This in itself supports the Law of Conservation of Mass in that every atom of every element in the reactants is accounted for on the products side of the equation—What goes in must come out!)

Post Lab Demonstration: To show the relatively high density of carbon dioxide as compared to air, “pour” the contained gas from Trial #2 into a beaker that has a short stub of a lit candle “waxed” to the bottom. The invisible, denser than air CO₂ fills the beaker and extinguishes the candle.